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Problems in the Silting of Dams

J. Gani, *University of California, Santa Barbara, CA, USA*

In the classical theory of dams, the content Z_t of a finite dam of capacity K at time $t=0,1,2,\ldots$, subject to i.i.d. inputs X_t in $(t, t+1)$ and a release M (or Z_t+X_t if it is less than M) at $t+1$ is given by

$$Z_{t+1}=\min\{Z_t+X_t, K\}-\min\{Z_t+X_t, M\},$$

where $\{Z_t\}$ forms a Markov chain.

A practical problem which arises in many dams is silting due to the sedimentation of particles from the water input into the dam. If Y_t denotes the amount of silt deposited in the dam in $(t, t+1)$, and the $\{Y_t\}$ are i.i.d., then $S_{t+1}=\sum_{n=0}^{t+1} Y_n$ is the total silt in the dam at time $t+1$, and its real capacity is $K_{t+1}=K-S_{t+1}$, a Markov chain. The real content of the dam is now

$$U_{t+1}=\min\{U_t+X_t, K_{t+1}\}-\min\{U_t+X_t, M\},$$

where $U_t=Z_t-S_t$, and $\{U_t, K_t\}$ forms a bivariate Markov chain whether the $\{X_t\}$, $\{Y_t\}$ are independent of each other or not. A practical theory of dams with silting can be developed on these assumptions.

Recent Results on Queues with Time Variations

E. Gelenbe*, S. Lefebvre and J.M. Vincent, *Laboratoire ISEM, Université de Paris Sud, Orsay, France*

In this paper we shall discuss some recent results concerning two approaches to modelling queueing systems with time variations in the context of specific applications.

We shall first examine a special type of queueing system called the resequencing queue. Here, the service mechanism is based on reconstituting the arrival sequence at the server by compensating for a random disordering delay which has been introduced before the service mechanism. This problem is of importance in communication networks and in distributed data base systems, where variations in traffic patterns with time are often present. The analysis available so far only assumed time independent arrival sequences. We provide analytical results for the time dependent Poisson arrival model, as well as for a slowly varying Markovian arrival process.

We then proceed to the case of queueing networks which may have time-of-day type variations in their arrival and service parameters, and provide analytical and numerical approximations to their stationary behaviour, and compare these approximations to the "naive" approximations which may be used.

Response Times in M/M/1 Time Sharing Schemes with Limited Number of Service Positions

Benjamin Avi Itzhak, *Technion, Haifa, Israel*
Shlomo Halfin*, *Bell Communications Research, USA*

Two service schemes for an M/M/1 time sharing system with a limited number of service positions are studied. Both schemes possess the equilibrium properties of symmetric queues, however in the first one, a preempted job is placed at the end of the waiting line; while in the second one, it is placed at the head of the line. Methods for calculating the Laplace transforms and moments of the response times are presented. The variances of the response times are then compared numerically to indicate that the first scheme is superior to the second scheme. It is also indicated that in both cases the response time variance decreases when the number of service positions increase.

Brownian Models of Open Queueing Networks

J.M. Harrison*, *Stanford University, Stanford, CA, USA*
R.J. Williams, *University of California, San Diego, CA, USA*

We consider a class of multidimensional diffusion processes that arise as heavy traffic approximations for open queueing networks. It is explained in concrete terms how one approximates a conventional queueing model by one of these Brownian system models, and some basic properties of such Brownian models are discussed. This is largely a recapitulation of earlier work on heavy traffic limit theorems, with the emphasis placed on modeling intuition.

Multichannel Queueing System with Semi-Ordered Entry

Masanori Kodama*, *Kyushu University, Fukuoka, Japan*
Jiro Fukuta, *Aichi University, Toyohashi, Japan*

We consider the multichannel queueing system with semi-ordered entry. The following assumptions are made for system operation:

(1) For the system: System has m parallel servers and channels of each server are denoted by $1, 2, \ldots, m$ respectively.

(2) For arrivals: (i) All arrivals arrive at a common entry for the system; (ii) arrivals are Poisson distributed, with mean arrival rate $= \lambda$.